Emissions from bio-based building products

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The study focused on the emission behaviour of wood and the occurrence of corrosion on lead coupons due to these emissions when both materials were combined in a modified Oddytest (Oddy 1973, modified). Wood may not seem like a challenging environment for corrosion but by its porous micro- and ultrastructure wood has complex interactions with water that greatly affects its physical, mechanical, and chemical properties, including corrosion (Zelinka 2014). Wood can be considered as one of the major emission sources of formaldehyde and other volatile compounds. During the kiln drying of wood, the hydrolysis of cell wall components (cellulose, hemicellulose and lignin) leads to formation of furfural, formaldehyde and very volatile acids, e.g. acetic and formic acid. In addition, at a relative humidity of 20 % an initial molecular layer of water on the metal surface can react with atmospheric formaldehyde to produce formic acid which in turn causes metal corrosion (Hatchfield et al. 1986).

The selected test set up consisted of wood species which are known to have low emissions such as Alder, and wood species with expected higher emission rates such as Ash and Oak. Six samples of each species were impregnated with a buffer-solution and were dried under vacuum conditions along with further six untreated samples to an absolute dry state. According to Cole (1979) a pH range of 3.3 to 7.2 for hardwoods (e.g. 5.5 for Alder and 3.3 to 3.9 for Oak) was found. All pH measurements were made with a WTW pH meter, Model inoLab according to the technique of Lambuth (1967). In this study the measurements of the emissions from wood were performed based on ISO 16000-10 (2006) with a micro-chamber. Specimens were installed under constant conditions with respect to temperature, relative humidity and air exchange rates. The samples were prepared according to ISO 16000-11, formatted (Ø 40 mm) and stored in a conditioning room (23 ± 2 °C and 50 ± 5 %). Prior to the tests, fresh surfaces were planed. The stainless steel cell allowed a controlled climate at 23 ± 1 °C and 50 ± 3 % RH. Using the Oddy test (Oddy 1973), potential damage of art objects through formaldehyde and organic acid (formic and acetic) vapour is seen to accelerate by the addition of a small amount of water (1 ml), elevation of temperature to 60 °C and storage for 28 days; this prompts the evolution of potentially corrosive gases from the test material and metal corrosion reactions.

The impregnation with the buffer solution led to the intended effect. The results showed that the buffer system with a pH value of 7.2 caused an increase of the pH values of the three different species: Alder (6.22 to 6.65), Oak 4.72 to 5.27) and Ash (5.82 to 6.82). The subsequently performed investigations of the emissions and the degree of corrosiveness were affected by the decreased acidity of the specimens (Fig. 1).

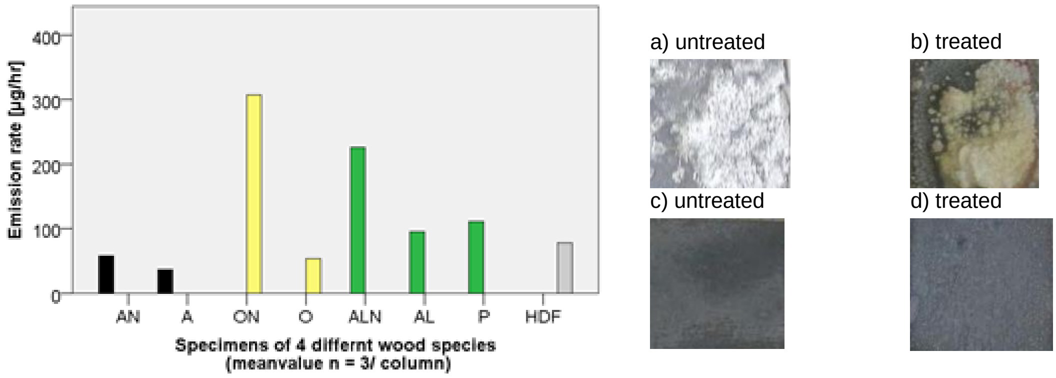

Figure 1: left: Sum of emissions of aldehydes consisting of C>2 (i.e. furfural, hexanal, heptanal, octanal, nonanal and decanal) AN = Ash untreated, A = Ash impreg., ON = Oak ut, O = Oak i., ALN = Alder ut, AL = Alder i.; right: lead coupons removed from Oddy test-vessel

The results indicated the positive influence of the buffer treatment on the chemical compounds. However, acet-, formaldehyde and VOCs possess very little corrosiveness towards materials like textiles, paper and metals. By contrast, vapours of organic acids (formic and acetic acid) are known to be reactants in the metal corrosion. This became visible after the Oddy tests when lead coupons were removed from the test vessels. Due to increased amounts of water available in the vessel, the results became more pronounced to the point of being rated as unsuitable because of heavy corrosions. Possibly usage of biobased products is limited in sensitive environment.

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